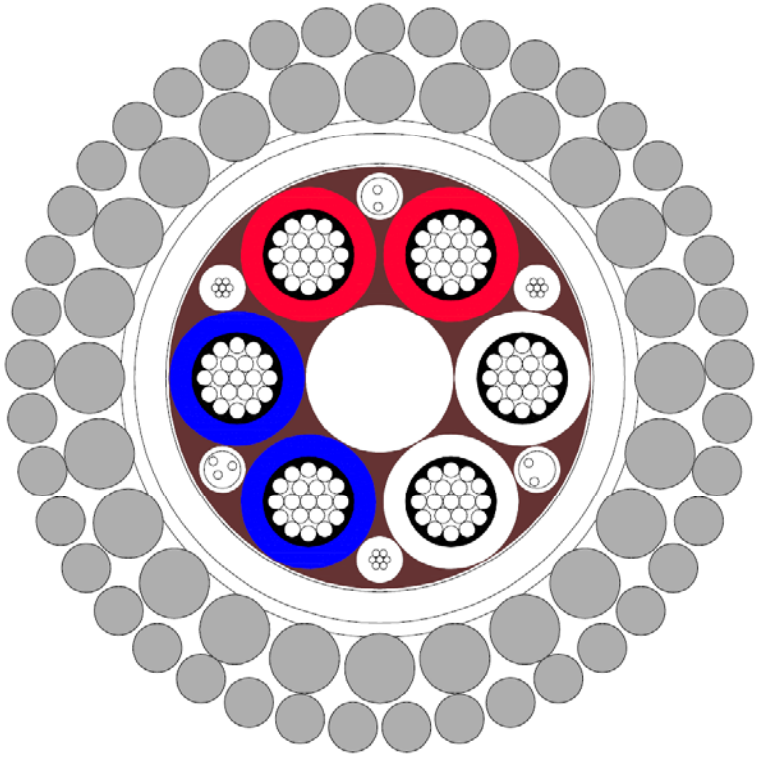
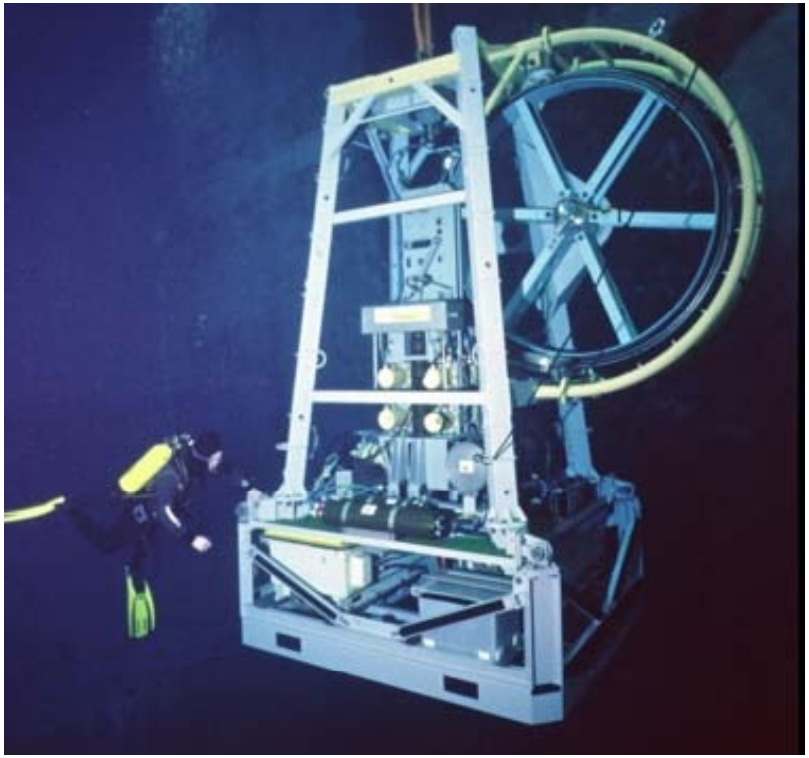
# OFEG-TECH – Bremen

## 7th Ocean Facilities Exchange Group
## 21st November 2013

# Outline

- This presentation will focus on 2 areas :
  - ROV cable feedback on 18 years
  - PENFELD refitting and evolutions

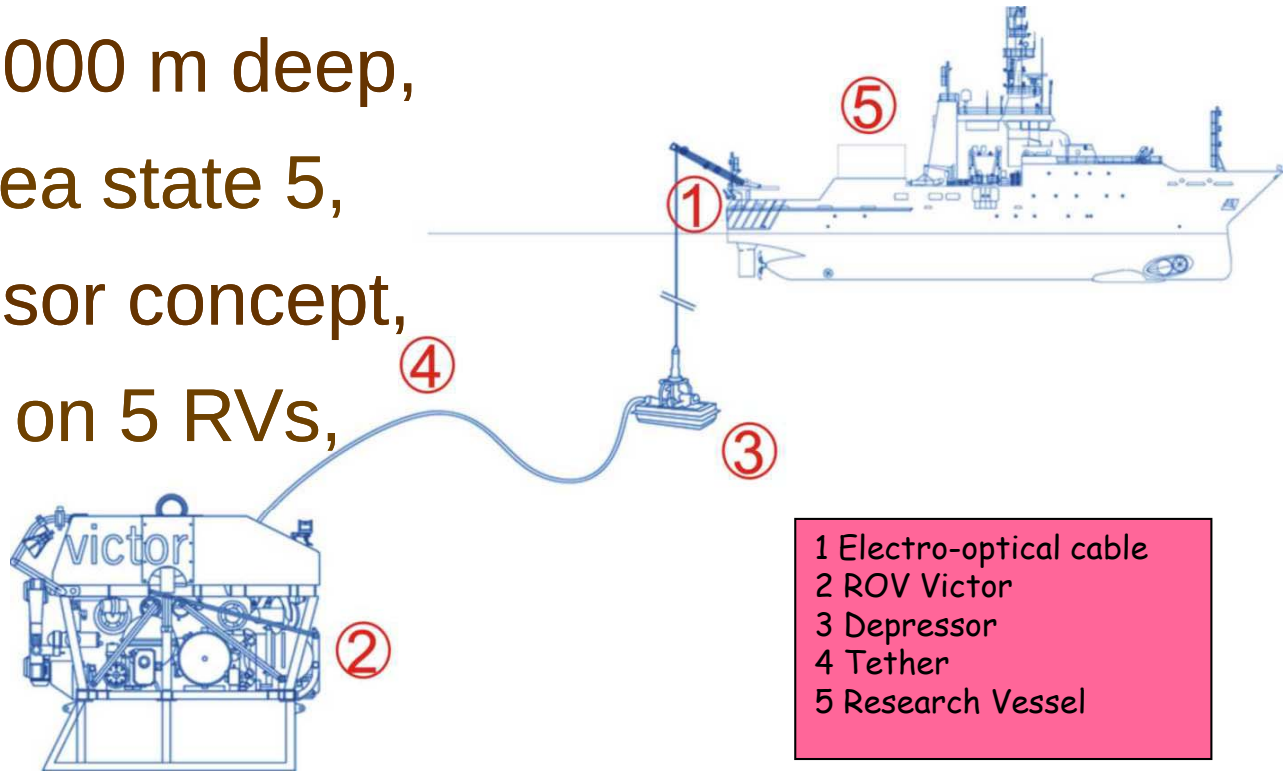




# 18 years feedback on the use of ROV cables

## ROV Victor system

- Main specifications
  - ✓ launched in 1995,
  - ✓ up to 6000 m deep,
  - ✓ up to sea state 5,
  - ✓ depressor concept,
  - ✓ usable on 5 RVs,




1 Electro-optical cable
2 ROV Victor
3 Depressor
4 Tether
5 Research Vessel

# 18 years feedback on the use of ROV cables

## ROV Victor system

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  - ✓ up to 6000 m deep,
  - ✓ up to sea state 5,
  - ✓ depressor concept,
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# 18 years feedback on the use of ROV cables

## Cable interfaces

- The first interface is located on the depressor
  - ✓ in-house unit,
  - ✓ load transfer,
  - ✓ optical connections,
  - ✓ electrical connections,
- The second interface is located on the drum
  - ✓ armors clamped on the flange,
  - ✓ connexions towards an EOSR,

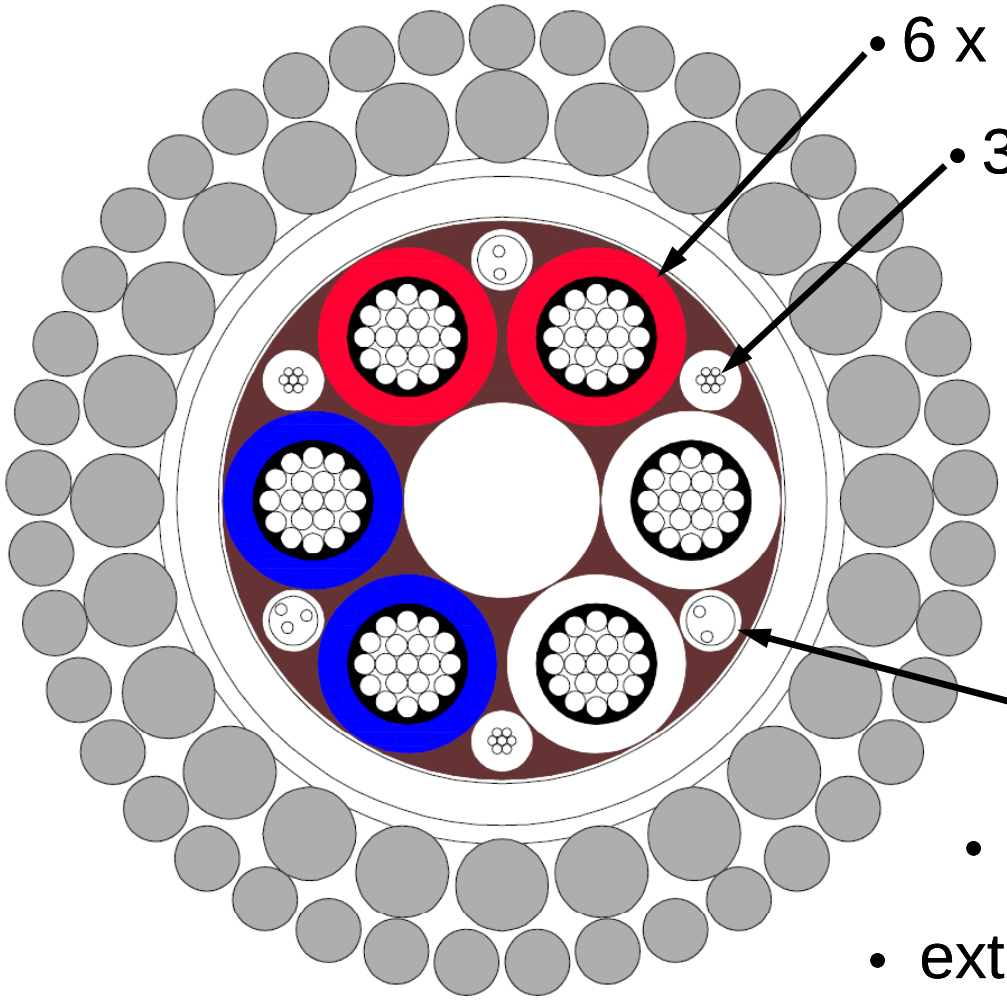
# 18 years feedback on the use of ROV cables

## Cable overview

- The cable must ensure the main functions :
  - ✓ upper working load……..95 kN,
  - ✓ remote control and data……3x 1300/1550nm,
  - ✓ power transmission…..3 phases 2kV@10.6A,
  - ✓ control power…….. 3 phases 400V@0.5A,
- With the following constraints :
  - ✓ encapsulated optical fibres (FIST system),
  - ✓ 6 power conductors (13 AWG),

# 18 years feedback on the use of ROV cables

## Cable overview



- 6 x 13AWG soft bare copper
- 3 x 24AWG tinned copper
- HDPE core

jacket diameter 14.10 mm
nominal diameter 20.65 mm

- 3 single-mode FIST
- inner armor 24 x 1.930 mm
- external armor 41 x 1.345 mm

# 18 years feedback on the use of ROV cables

## Mobile and direct winch

- Main characteristics :
  - ✓ 25 tonnes
  - ✓ 132 coils
  - ✓ 15 layers
  - ✓ D/d > 58
  - ✓ 150kN@1.5m/s

# 18 years feedback on the use of ROV cables

## Traction winch of the RV *Pourquoi pas ?*

- Main characteristics :
  - ✓ 126 coils
  - ✓ 15 layers
  - ✓ D/d > 58
  - ✓ 10 kN back tension
  - ✓ 150kN@2.0m/s

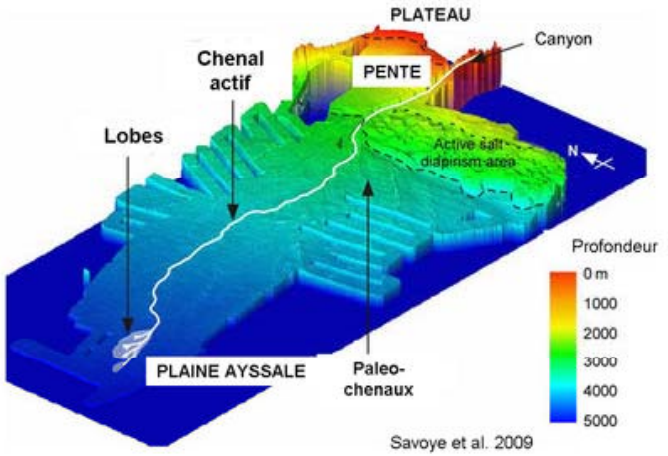
5 sheaves between the surface of the sea and the capstan

# 18 years feedback on the use of ROV cables

## Typical mission

### WACS (West Africa Cold Seeps)

| Date | Dive duration | at depth duration | Depth of the dive | Distance covered |
|---|---|---|---|---|
| 30/01/2011 | 23:28 | 18:40 | 3149 m | 34.3 km |
| 02/02/2011 | 18:17 | 13:47 | 3154 m | < 1.0 km |
| 03/02/2011 | 06:57 | 03:07 | 3154 m | 5.0 km |
| 05/02/2011 | 13:29 | 09:20 | 3157 m | < 1.0 km |
| 08/02/2011 | 07:17 | 03:07 | 3157 m | 3.2 km |
| 09/02/2011 | 16:26 | 12:07 | 3157 m | 2.5 km |
| 10/02/2011 | 16:53 | 14:10 | 3157 m | 3.6 km |
| 12/02/2011 | 13:56 | 09:29 | 3102 m | 7.0 km |
| 13/02/2011 | 11:07 | 06:38 | 3102 m | 0.8 km |
| 14/02/2011 | 10:12 | 06:37 | 3001 m | 3.0 km |
| 15/02/2011 | 16:27 | 15:06 | 689 m | 4.8 km |
| 20/02/2011 | 02:14 | 00:00 | 688 m | 0.0 km |
| 20/02/2011 | 05:08 | 23:20 | 4790 m | 7.2 km |
| 22/02/2011 | 21:52 | 15:48 | 4946 m | 6.5 km |
| 24/02/2011 | 20:20 | 14:42 | 4946 m | 1.0 km |
| 26/02/2011 | 13:46 | 06:56 | 5040 m | 5.0 km |




| | |
|---|---|
| Days at sea | 32 |
| Number of dives | 16 |
| On the way | 152 h |
| Standby du to the weather | 0 h |
| Total duration of the dives | 218 h |
| Average duration of the dives | 14 h |
| Total duration at depth | 173 h |
| Average duration at depth | 11 h |
| Maximum depth | 5040 m |
| Average depth | 3274 m |

# 18 years feedback on the use of ROV cables

## The ROV cables

- 18 years - 4 cables - 413 dives
  - ✓ 1995 - 2002 - Schlumberger - 2128 hours,
  - ✓ 2002 - 2010 - Schlumberger - 2700 hours,
  - ✓ since 2010 - Schlumberger - 712 hours,
  - ✓ 2005 - 2013 - Schlumberger - 1160 hours,
  - ✓ since 2013 - Rochester - one dive for SAT,

# 18 years feedback on the use of ROV cables

## The ROV cables

- 18 years - 4 cables - 413 dives
  - ✓ 1995 - 2002 - Schlumberger - 2128 hours,

01/1999 : insulation defect on 13AWG (-1000m)
11/2001 : insulation defect on 13AWG
03/2002 : insulation defect on second 13 AWG (-3274m)
06/2002 : replacement of the first cable after 170 dives

After inspection and analysis carried out by the supplier, it was stated that the design of the cable and the materials were not the cause of these defects.

# 18 years feedback on the use of ROV cables

## The ROV cables

- 18 years - 4 cables - 413 dives
  - ✓ 2002 - 2010 - Schlumberger - 2700 hours,

    10/2007 : insulation defect on 13AWG (-3950m)
    10/2010 : replacement of the second cable after 150 dives

After inspection and analysis carried out by the supplier, it was stated that the design of the cable and the materials were not the cause of these defects.

# 18 years feedback on the use of ROV cables

## The ROV cables

- 18 years - 4 cables - 413 dives
  - ✓ since 2010 - Schlumberger - 712 hours,

10/2010 : defect on external armor at 1175 m
12/2011 : breaking of a 24AWG conductor

During BOS tests , the first failure of the sample was the breaking of a 24AWG conductor after 13429 cycles.

Up to now, the supplier has not replied to our questions !

# 18 years feedback on the use of ROV cables

## The ROV cables

- 18 years - 4 cables - 413 dives
  - ✓ 2005 - 2013 - Schlumberger - 1160 hours,

10/2007 : insulation defect on 13AWG (- 4100m)
10/2013 : replacement of the cable after 60 dives

New analysis :
'No test results can jeopardize the quality of the offending insulation although some assumptions remain suspicious.'

# 18 years feedback on the use of ROV cables

## The ROV cables

- 18 years - 4 cables - 413 dives

| | EOM 1 | EOM 2 | EOM 3 | EOM 4 |
|---|---|---|---|---|
| Used during (months) | 88 | 99 | 99 | _ |
| First snag after (months) | 47 | 64 | 24 | 14 |
| Total dives (_) | 170 | 150 | 60 | 33 |
| Total hours (_) | 2128 | 2700 | 1160 | 712 |
| Average duration of dives (h/u) | 12.5 | 18.0 | 19.3 | 21.6 |
| Linear cost of the cable (€/m) | 26 € | 26 € | 28 € | 32 € |
| Dive cost (€/u) | 1 299 € | 1 497 € | 3 951 € | 8 242 € |
| Hour cost (€/u) | 104 € | 83 € | 204 € | 382 € |

How to explain the fall in capabilities ?

# 18 years feedback on the use of ROV cables

## The ROV cables

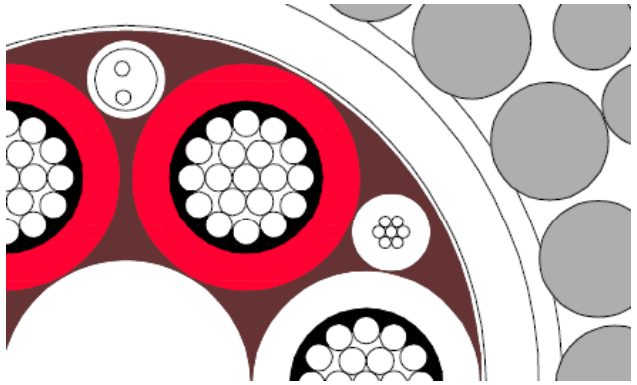
- What was identical ?
  - ✓ Electrical specifications were similar,
  - ✓ Optical specifications were similar too,
  - ✓ Jacket and nominal diameter were identical,
  - ✓ Mechanical tests were the same,
- What was different ?
  - ✓ Design of conductors,
  - ✓ Recommended and Safety Working Load,

# 18 years feedback on the use of ROV cables

## The electrical conductors

| Insulation materials | EOM 1 | EOM 2 | EOM 3 | EOM 4 | EOM 5 |
|---|---|---|---|---|---|
| 13AWG | LDPE | LDPE | XLPE | PE+LDPE+PA | HDPE |
| 24AWG | LDPE | EPC | EPC | EPC | HDPE |
| FIST | bare tube | bare tube | bare tube | PA jacketed | bare tube |

**EPC** Ethylene-Propylene Copolymer
**LDPE** Low Density PolyEthylene
**MDPE** Medium Density PolyEthylene
**HDPE** High Density PolyEthylene
**XLPE** Cross-Linked PolyEthylene
**TR-XLPE** Tree-Retardant XLPE



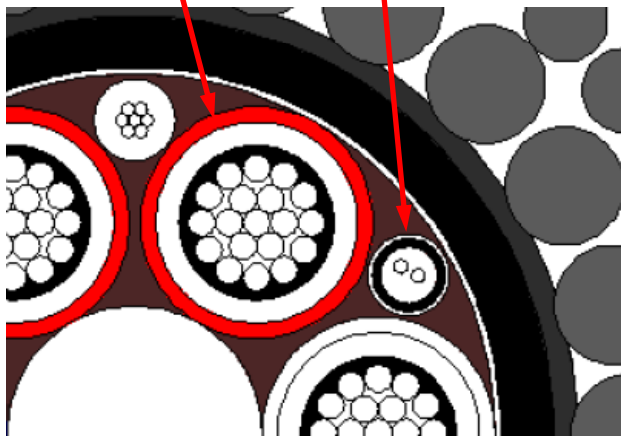
# 18 years feedback on the use of ROV cables

## The electrical conductors

| Insulation materials | EOM 1 | EOM 2 | EOM 3 | EOM 4 | EOM 5 |
|---|---|---|---|---|---|
| 13AWG | LDPE | LDPE | XLPE | PE+LDPE+PA | HDPE |
| 24AWG | LDPE | EPC | EPC | EPC | HDPE |
| FIST | bare tube | bare tube | bare tube | PA jacketed | bare tube |

Improvements have been done to avoid insulation breakdown on the 13AWG conductors :

- EOC2 to EOC3,
- EOC3 to EOC4,



# 18 years feedback on the use of ROV cables

## The electrical conductors

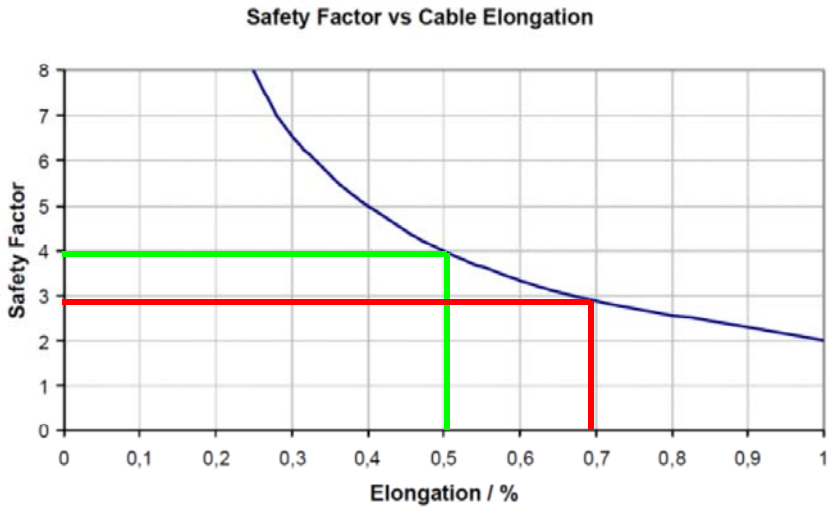
| Insulation tests | EOM 1 | EOM 2 | EOM 3 | EOM 4 | EOM 5 |
|---|---|---|---|---|---|
| Before laying the armors | | | | | |
| between 13AWG | 5.0 kVdc | 3.0 kVdc | 5.0 kVdc | 5.0 kVdc | 5.0 kVdc |
| between 24AWG | _ | 1.0 kVdc | _ | _ | 0.8 kVdc |
| between 13AWG and FIST | _ | _ | 3.0 kVdc | 3.0 kVdc | 3.0 kVdc |
| between 24AWG and FIST | _ | _ | _ | _ | 0.8 kVdc |
| After laying the armors | | | | | |
| between 13AWG | 5.0 kVdc | 4.0 kVdc | 4.0 kVdc | 4.0 kVdc | 4.0 kVdc |
| between 24AWG | _ | 1.0 kVdc | _ | _ | 0.5 kVdc |
| between 13AWG and FIST | _ | _ | 3.0 kVdc | 3.0 kVdc | 3.0 kVdc |
| between 24AWG and FIST | _ | _ | _ | _ | 0.5 kVdc |
| 10 mn in hot water (60°C) | | | | | |
| 100 m of 13AWG | _ | _ | 3.0 kVdc | 5.0 kVdc | 5.0 kVdc |
| 100 m of 24AWG | _ | _ | _ | _ | 0.8 kVdc |

Increase in the number of insulation tests !

# 18 years feedback on the use of ROV cables

## The working loads

| Tension line | EOM 1 | EOM 2 | EOM 3 | EOM 4 | EOM 5 |
|---|---|---|---|---|---|
| Breaking Strength | 202.4 kN | 220.0 kN | 239.6 kN | 239.6 kN | 240.0 kN |
| Minimum Breaking Load | 200.7 kN | 227.5 kN | 212.4 kN | 219.3 kN | 244.5 kN |
| ***Δ BS/MBL*** | ***-0.8%*** | ***+3.4%*** | ***-11.4%*** | ***-8.5%*** | ***+1.9%*** |
| Recommended Working Load | 81 kN | 81 kN | 72 kN | 60 kN @ 0.6% | 60 kN @ 0.4% |
| ***Safety factor*** | ***2.5*** | ***2.8*** | ***3.0*** | ***3.7*** | ***4.1*** |

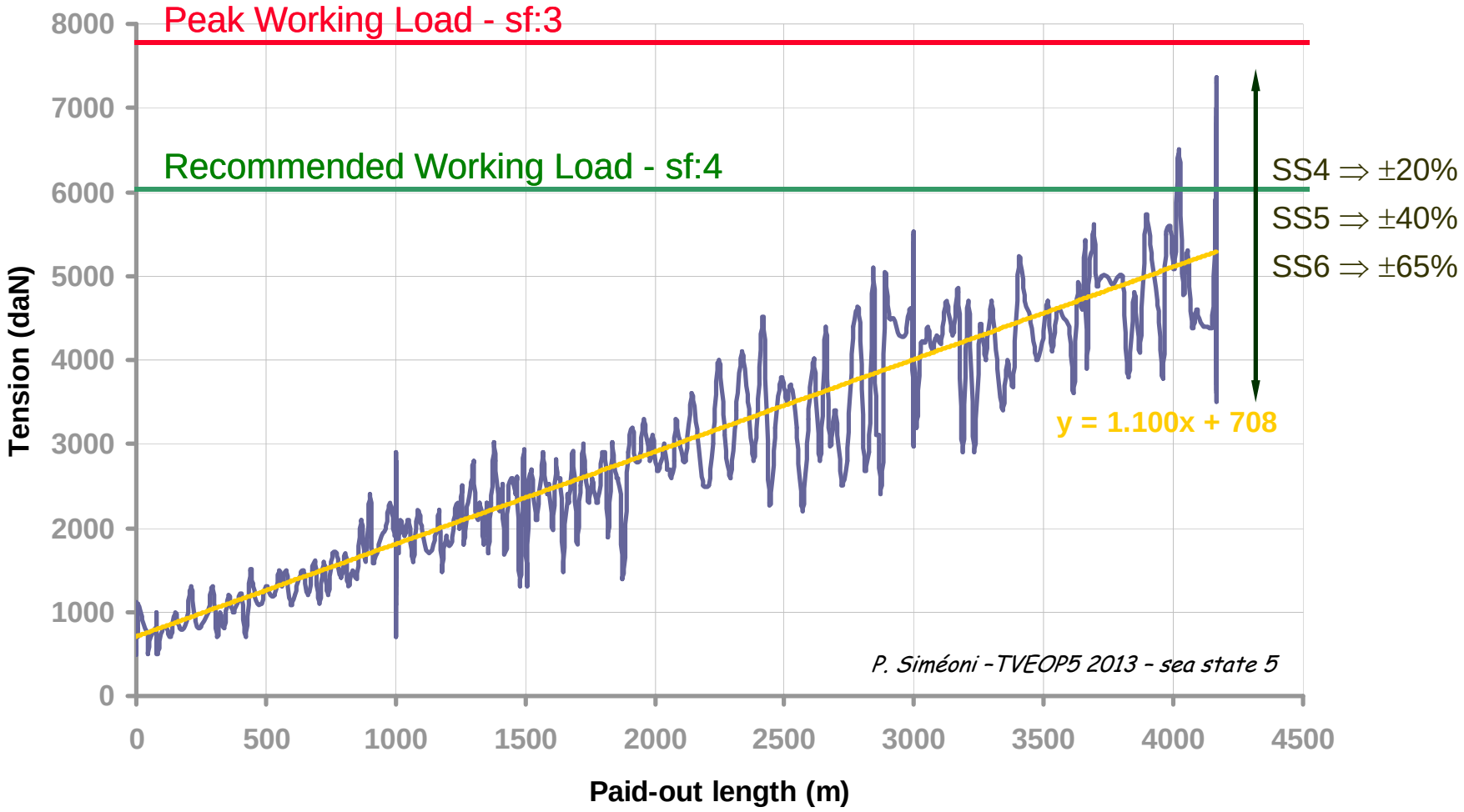



‘We strongly recommend a safety factor of 4. At this point the cable elongation is approx. 0.5%. Only for emergency cases (a smooth increase on tension and no snatches) a safety factor of 3 is acceptable.’

*Courtesy of Rochester*

# 18 years feedback on the use of ROV cables

## The working loads



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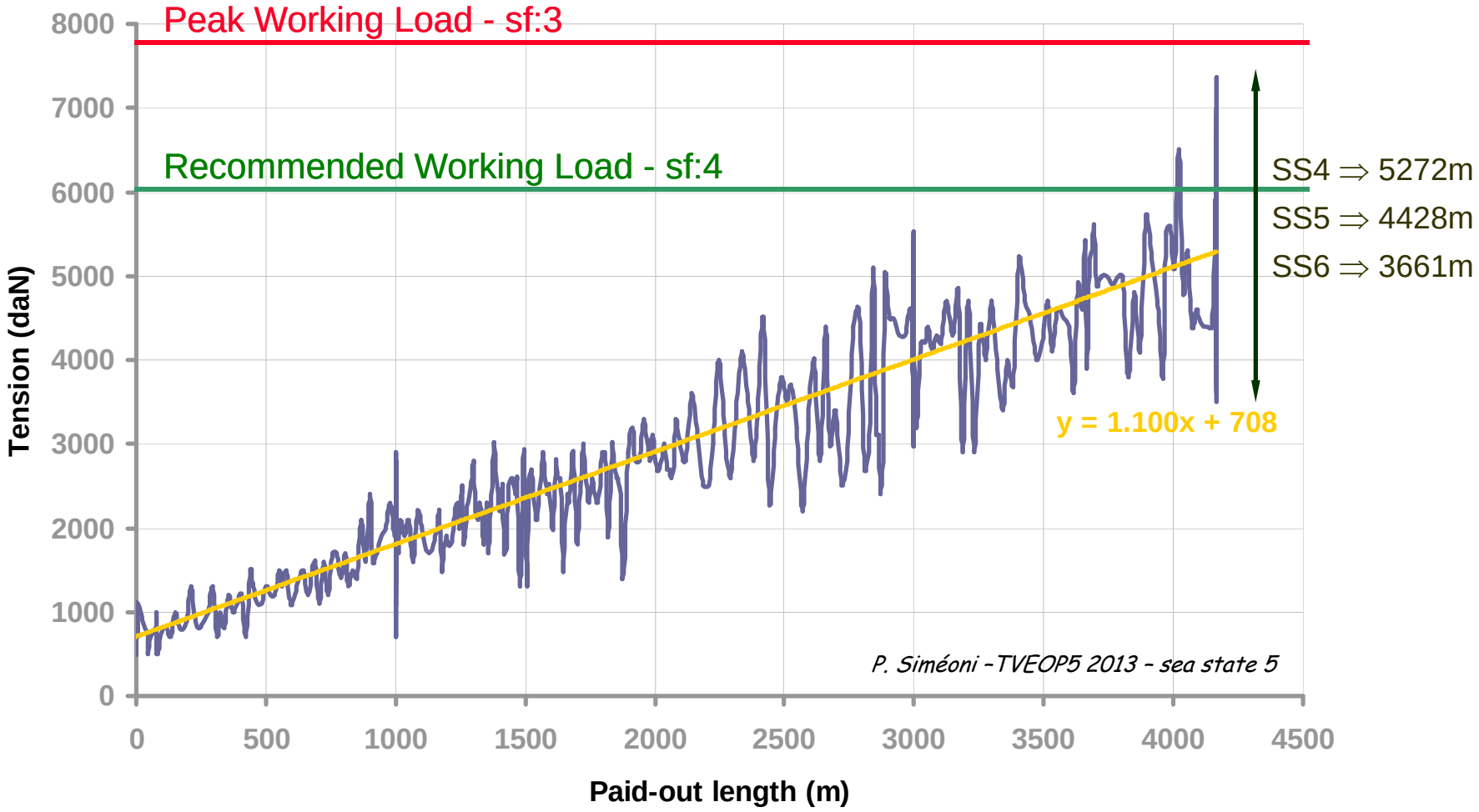
## The working loads



# 18 years feedback on the use of ROV cables

## Cable life time required

- Long stroke bending fatigue
  - ✓ 60 dives per year during 4 years
  - ✓ On direct winch, 3 sheaves ⇒ 1440 cycles
  - ✓ On the Pp?, 27 sheaves ⇒ 12960 cycles
- Short stroke bending fatigue
  - ✓ 3 days at the same depth
  - ✓ 6 to 10 seconds swell period
  - ✓ that means 26 to 43 kcycles

# 18 years feedback on the use of ROV cables

## Bending fatigue tests

| BOS - Fatigue tests | Prototype (1993) | EOM 1 (1995) | EOM 4 (2010) | EOM 5 (2013) |
|---|---|---|---|---|
| | Ω machine | Ω machine | single sheave | single sheave |
| **Number of machine cycles** | **16988** | **15000** | **13429** | **20000** |
| Tension | $95^{\pm 10}$ kN | 20 kN | 60 kN | 78 kN |
| Results - failures | o.f. and wire | 13 AWG | 24 AWG | null |
| **Number of machine cycles** | **9151** | **15997** | **12005** | **20000** |
| Tension | $85^{\pm 20}$ kN | 20 kN | 60 kN | 78 kN |
| Results - failures | o.f. and wire | 13 AWG | 24 AWG | null |
| **Number of machine cycles** | **15200** | **18334** | | **20000** |
| Tension | $70^{\pm 10}$ kN | 20 kN | | 78 kN |
| Results - failures | null | steel wire | | null |
| **Number of machine cycles** | **19022** | | | |
| Tension | $70^{\pm 10}$ kN | | | |
| Results - failures | 13 AWG | | | |

6 BOS / machine cycle

2 BOS / machine cycle

# 18 years feedback on the use of ROV cables

## Some questions to be answered

- Have we resolved insulation issues ?
  - ✓ the future will tell !
- How do we maintain the 6000 m capacity ?
  - ✓ should we single out athwart ship operations
  - ✓ should we rethink the specifications
- Is the life-span of our cables an acceptable standard ?

# Outline

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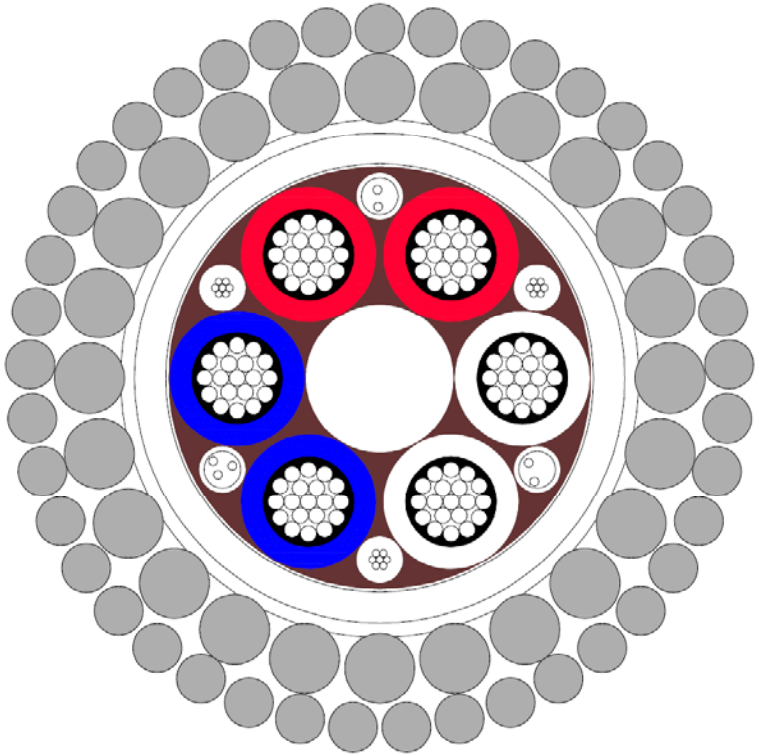
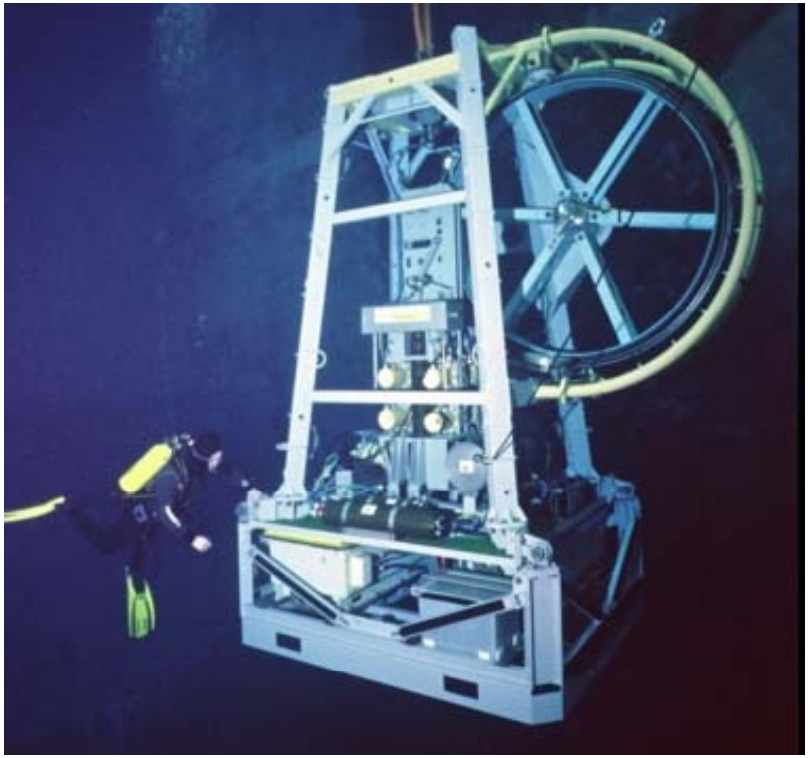
  - ROV cable feedback on 18 years
  - PENFELD refitting and evolutions

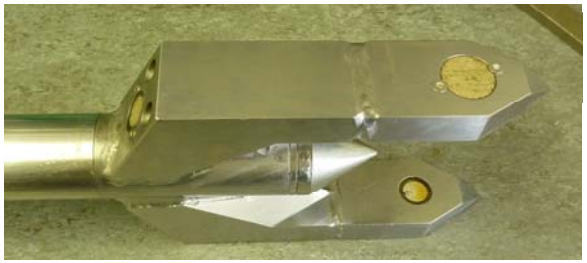


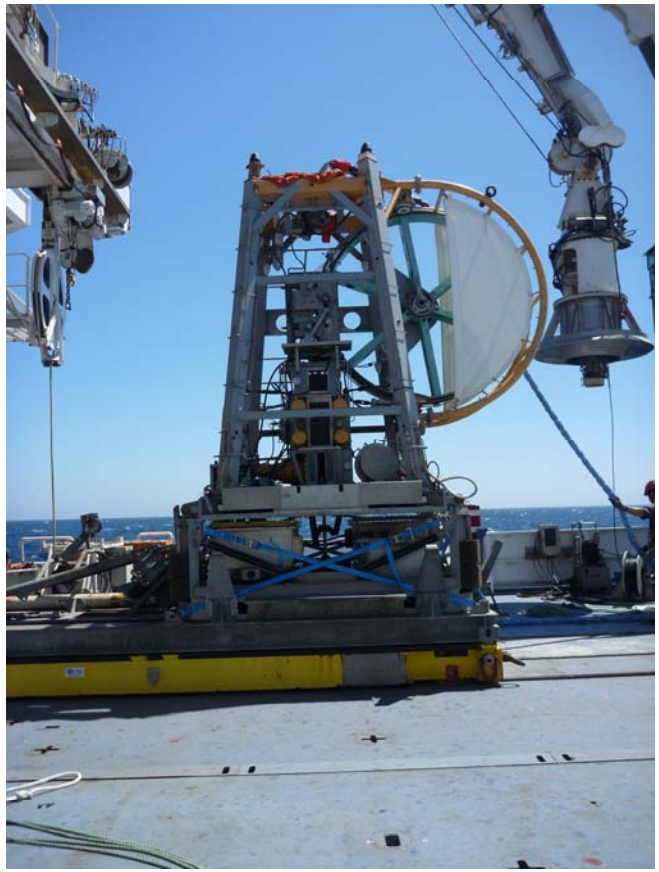


# Refitting and evolutions of PENFELD

## The penetrometer Penfeld

- pushing force up to 30 kN
- 30 meters long rod
- CPT tip or Vp tip
- self-powered
- weight in air 67 kN



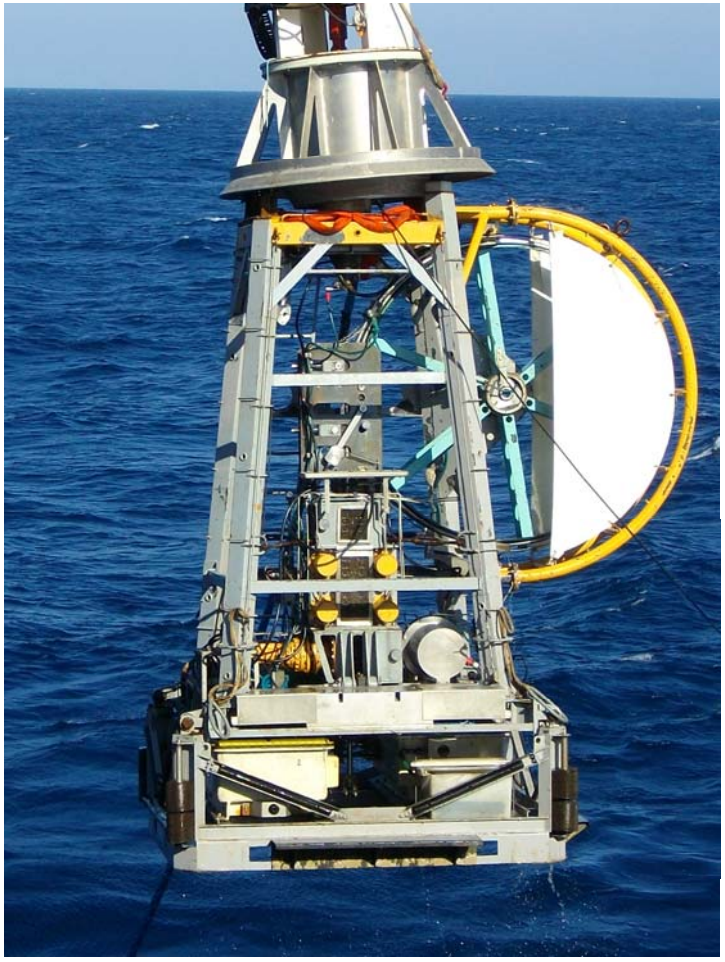


# Refitting and evolutions of PENFELD

## Refitting and first evolution

- Pushing force up to 50 kN
- 50 meters long rod
- Weight in air 95 kN
- Up-to-date PLC system

should be tested in september 2014

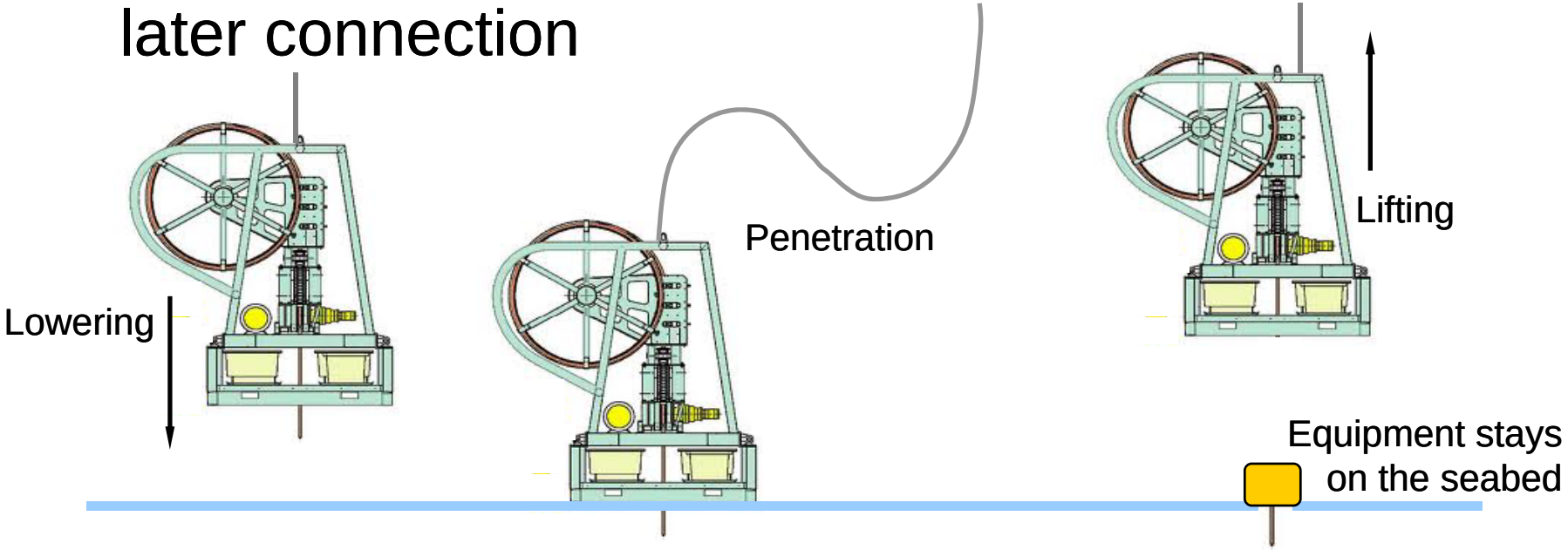


# Refitting and evolutions of PENFELD

straight

## Second evolution

- To push into the sediment any instrumented rod as piezometers, tiltmeters, …
- To leave on the spot the rod ready-to-use for a later connection



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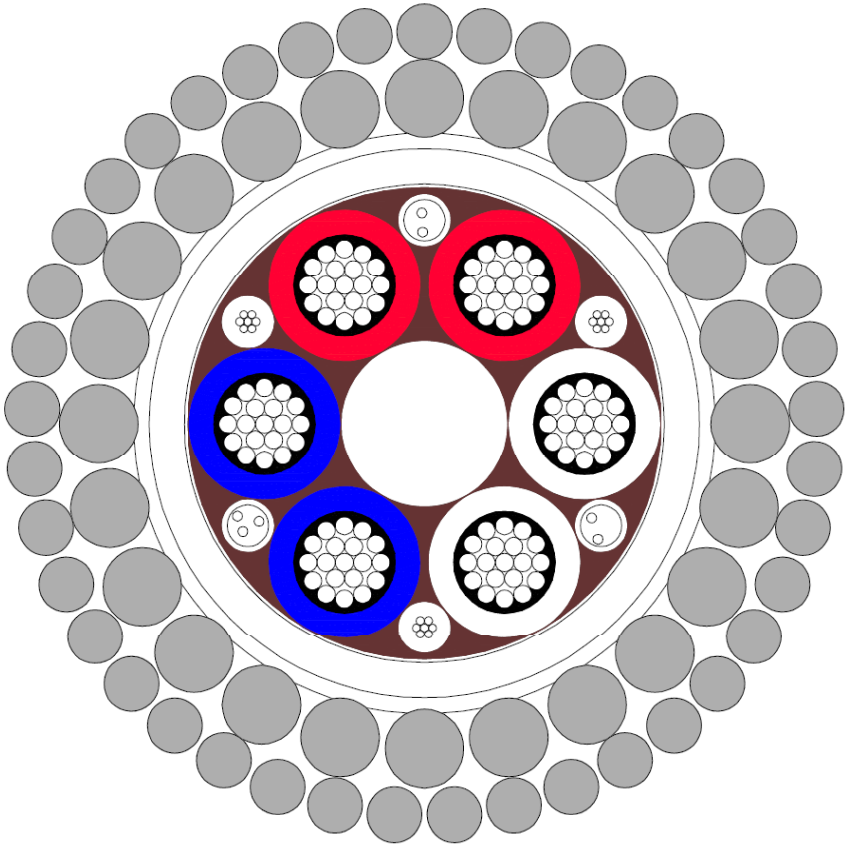

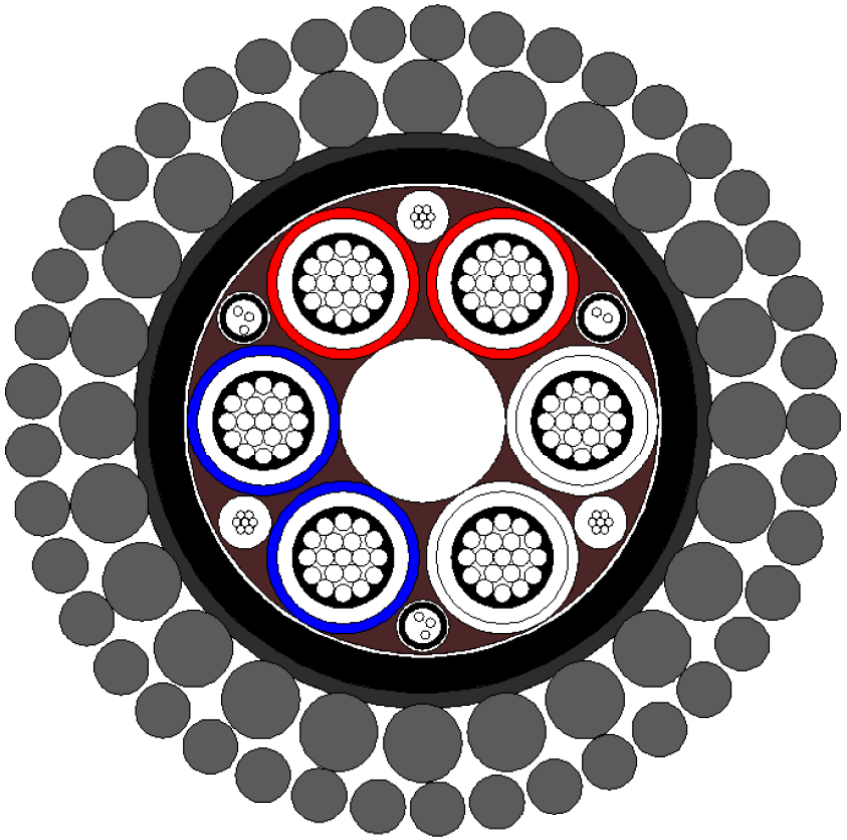

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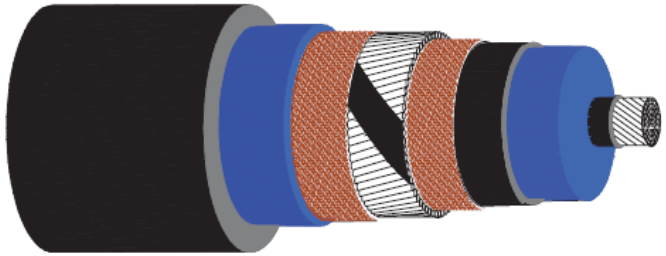

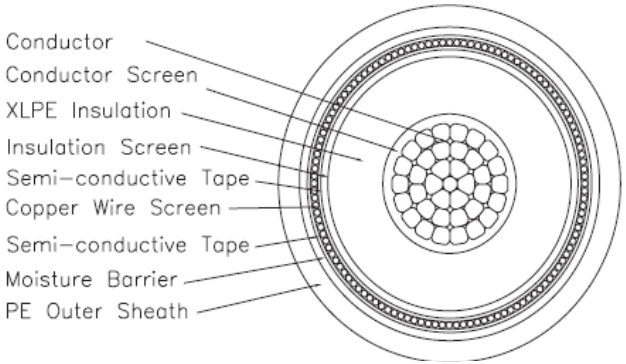


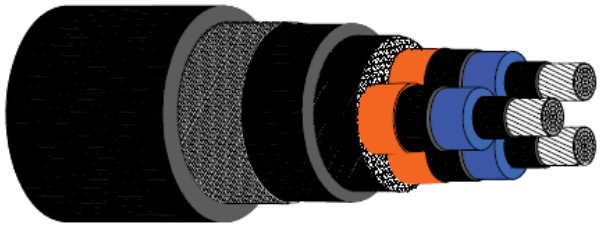

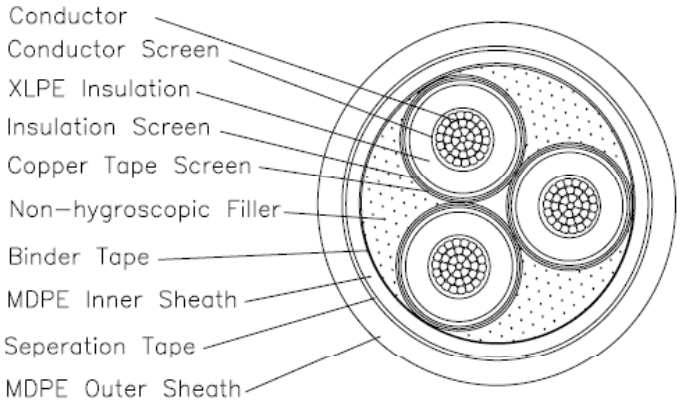


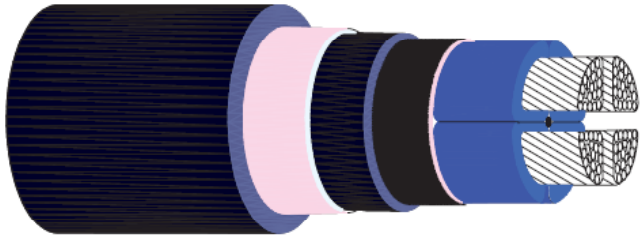

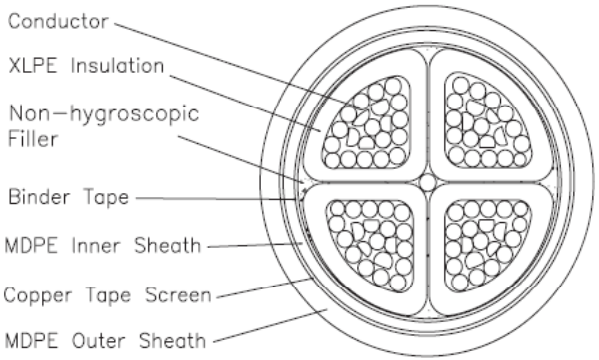

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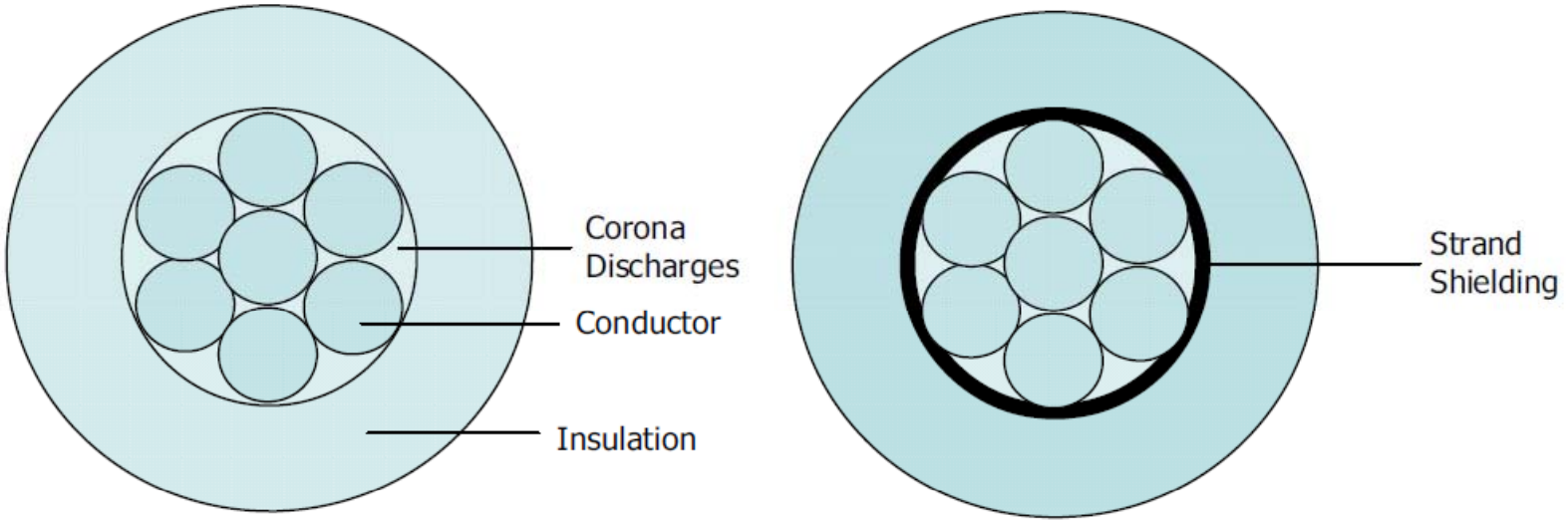

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